

The Language Problem in Problem Solving in Basic School Mathematics

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ABSTRACT

The use of English or a second language in teaching mathematics is one of the major factors that discourage teachers from teaching problem solving. My personal experience has been that about half of the pupils completing primary schools in Ghana today have not had any grasp over the basic mathematical concepts in either their first language or the official medium of instruction. They can rarely relate the mathematical knowledge gained from school to solving problems involving situations outside the classroom. This unfortunate situation can be attributed to some extent to the fact that many teachers tend to ignore the problem of language in mathematics.

In order to help teachers to reduce the language barriers in children's efforts to solve problems, this presentation examines mathematics teaching in a second language and its associated difficulties. It also considers proposals that will reduce pupils' difficulties in solving problems in basic schools.

Mathematics and Language

Language plays an important role in the teaching/learning process. Torbe (1982) pointed out that

without language, without the telling and listening, the reading and the writing which fills every school day, there could be no communication and no educational process - it is language which makes the whole educational process possible.

Mathematics, as a language, provides a means of communicating information because it makes use of symbolic notation. Mathematical language requires using and interpreting this symbolic notation and grasping the abstract ideas and concepts which underlie it. For this reason, even many people for whom English is their first language find it difficult to use language in mathematics.

To understand and communicate a mathematical idea in English, most children have to translate it into their first language and translate it back into English. Orton (1988) argues that

errors and misunderstandings might arise at any stage of this two-way inner translation process which children, who are not taught in their first language, undergo any time they want to communicate an idea in mathematics.

In mathematics, one's native language has to illuminate and translate the symbolic language. Native language provides a means of communication which is in use all the time and which, for a great majority of pupils, comes naturally', even though command of

language needs to be developed through experience. Native language can convey its meaning intelligibly despite mistakes of grammar or of spelling. In contrast, mathematics does not 'come naturally' to most people in the same way as native language. It is not constantly used; it has to be learned and practised; it obeys exact rules; and it does not convey meaning except by exact interpretation of its symbols.

The problems of learning to use mathematics as a means of communication can therefore not be the same as those of learning one's native language. A majority of teachers tend to ignore the fact that many people take a long time not only to become familiar with mathematical skills and ideas but to develop confidence in making use of them. They hardly wait until children can discuss and translate problems, presented orally, into appropriate mathematical terms before they introduce them to the written form. This first and essential step presents very great difficulties to many pupils in problem solving.

Research studies indicate that several of the errors children make when solving problems occur before they reach the stage where they have to use process skills or do calculation; they occur at the reading, comprehension or transformation levels (Newman, 1977; Clements, 1980). These are basically problems with

- language-complexity,
- syntax,
- amount of information given, and
- inability to relate mathematics to the context

Perhaps too much emphasis has been laid upon what is called 'correct mathematical language' and not enough on pupils' mathematical language. Macnab and Cunmine (1986) argued that 'a pupil who cannot talk about his mathematical work even in his own comparative simple language is a pupil who does not fully understand what he is doing'. The child's inability to use language in mathematics will not only hinder his understanding of the subject but will also prevent the teacher from having a deeper insight into the child's grasp of mathematics.

Difficulties in learning Mathematics in English as a Second Language

In the first three years of primary education, the policy on medium of instruction, requires that pupils in each school are taught mathematics in the local Ghanaian language. In spite of this, concepts about sets, shapes, patterns, space and problem solving, which are all in the primary school syllabus, are not thoroughly mastered before children begin to learn the subject in a second language. As early as Primary Class 1 children are helped to learn in English not only the names for numbers but also the names for the basic number operations, '+', '-', '=', '<' and '>'. Children's work in mathematics in many schools is reduced to learning English words and their meanings. And this only allows them to learn rules and procedures which they use to find correct answers to questions without knowing why the rule works. Children are not encouraged to see mathematics as part of their own language.

Language is important not only as a tool for communication but also as a tool for constructing thoughts and forming concepts. According to Vygotsky (1962), 'concepts and language are not only inextricably linked but concept formation depends on linguistic development'. One thing that can be deduced from this theory is that giving the beginner instruction or teaching him in a second language could lead to a retardation in his cognitive development because of the way concepts are applied in different cultures.

Dawe (1983) observed in his study on *'Bilingualism and Mathematical Reasoning in English as a Second Language'*, and pointed out, that

the ability of the child to make effective use of the cognitive functions of his first language is a good predictor of his ability to reason deductively in English as a second language.

Therefore as the language for thinking is always likely to be in the first language, the use of English in teaching, at levels where children have not yet mastered the mechanics of reading, writing and expressing their first language, is likely to inhibit the rate at which they will progress in learning mathematics. A concept or process in mathematics that a six year old child will be able to grasp when taught in the first language will sometimes have to be delayed until the child enters the upper classes in the primary school. Problem solving is one of the important mathematics processes delayed. As the child usually thinks in the first language, it is more likely that he will be successful at

solving problems posed in a second language if he has already acquired some experience in solving similar problems in his first language. Hence problem solving is sometimes delayed until pupils can solve problems in the first language.

When English as a second language is used in teaching mathematics, children's participation in learning is always passive. Most of the talking is done by the teacher. Interaction is always from teacher to child. 'Child-teacher' or 'child-child' interactions are almost non-existent. Children find it difficult to make full statements or express their thinking more completely in complex sentences at one stretch. Collison (1975) observed that “the trend of the child's response or contribution while learning in the second language is generally a simple sentence not well structured, a phrase or a word at a time”. And since children cannot take active part in lessons by talking about what they learn, they are likely to forget most of the things that they learn.

In spite of the fact that many teachers have a poor command over the English language, materials in textbooks provide limited ways of explaining concepts to pupils. But teaching the subject is based strictly on the textbook materials which in most cases ignore the rich mathematics inherent in many activities in the child's culture and environment. Many teachers are also not aware or tend to ignore the fact that most of the materials in the mathematics textbooks have been lifted directly from schemes written for pupils for whom English is the first language. It has to be noted that many pupils find it difficult to use some of the vocabulary in such texts even though they are using the first, and often only, language (Otterburn and Nicholson, 1976; Nicholson 1977). The result is that teachers often use a great deal of their teaching time in explaining words, ideas and instructions instead of engaging children in meaningful discussions based on materials in the environment which can bring about a better understanding.

Difficulties in Learning Problem Solving in Ghanaian Basic Schools Mathematics

There is a growing realisation that people need to learn and 'make more use' the knowledge and skills they acquire at school in solving problems they encounter in everyday life. Though there have been emphases on the teaching of problem solving in

school mathematics, much is yet to be achieved in helping children to solve problems. Teachers find it difficult to teach it. Problem solving is unpopular in schools because many teachers do not know how to introduce it in the classroom; how to solve problems themselves; and why children find it so difficult to learn it.

In Ghana, children's inability to use language in mathematics is one of the major factors which accounts for the general poor performance in the subject. This is because mathematics is generally taught in English, a language which is neither the teacher's nor the learner's first language. Pupils are not offered enough opportunities to talk about and record what they learn in their own language before they start learning in the official medium of instruction. As a result many pupils find it difficult to solve problems.

While the *reading ability and comprehension* of most primary school pupils in the country continue to fall, the rate at which new mathematical vocabulary is introduced has not changed. The amount of new mathematical vocabulary which children are expected to be introduced to in English each year from the mathematics textbooks is considerable. It is also interesting to note that several of these words are not written in the texts. They appear mainly as symbols with a hope that children will be able to decode them more easily than the textual material. Children therefore find it rather difficult to recognise or understand several of the words that they come across in their work in mathematics.

Difficulties in syntax and symbolism can sometimes lead to confusion. One of the common syntactical difficulties that occur in teaching mathematics is that of the *word-order* of mathematical expressions. In many African countries the numeral-word following the noun is the order. Let us consider the expression '¢5'. In the child's first language, he recognises it as '*cedis five*'. But in English he is supposed to read it '*five cedis*'.

Also there could be problems with the use of logical connectors and *quantifiers*. The use of such words as *if, of, all, some, many, and only*, may have conflicting uses in the first and second languages. For instance, $\frac{1}{4} \times \frac{1}{2}$ verbalises '*a quarter of half*' in English, but in Ewe, a Ghanaian language, the same expression verbalises '*kôta fe af*', or '*akpaenelia fe afa*' which translates into English as '*quarter, half of it*' or '*a fourth, , half of it*'.

Children are rarely offered opportunities to relate the mathematics they do in school to practical or everyday life situations. Textbook problems given to them are sometimes stated in such a way that the underlying semantic relations between the given and the unknown quantities reduce the reality of the problem. In some of the problems too, the information provided in the problem-statement is not enough. For example, the problems stated below, taken from the 'Ghana Mathematics Series Book 4' (Ministry of Education, 1988) are not real.

Exx 2.3 (a)

Agbodza's father has 287 goats. Each goat gives 4 litres of milk every day. How many litres of milk does Agbodza's father get every day?

Exx 2.3 (b)

A teacher has 24 exercise books. Each book has 48 leaves. He cut the books apart and gave each pupil in his class eight leaves. How many pupils are in his class?

This is because all over the country goats are not usually reared in such large numbers by individuals. Milking a goat is rarely practised and, even where it is done, a goat can hardly produce almost a gallon of milk every day. It looks as if the problem was originally about cows and therefore substituting a goat for a cow undermines its realism.

The second problem has not got enough information to enable the solver to come out with a solution which will make sense. In solving the problem it is expected that the solver will assume the teacher gave out all the exercise books to the pupils. The solution (i.e. 144 pupils), which is obtained by using this assumption, will not make much sense to many primary school children in Ghana because total enrolment in most primary schools in the country is below 150 pupils.

The poor manner in which problems are sometimes stated as well as the low ability to read and comprehend make it hard for many children to sift relevant information from irrelevant information in order to understand a problem. In view of these, children confine their reading largely to picking out the numbers in the text and finding 'cue words' to help them to decide what operation to perform on the numbers they have picked out.

In the final part of this presentation, ways of reducing language difficulties which children encounter in solving problems in a second language will be considered. Detailed

activities which can be used to improve such basic communication skills as reading, explaining, writing and questioning which are necessary for problem solving are discussed.

Reducing Language Difficulties in Problem Solving

Reading and understanding problems

One of the important functions that textbooks and other written materials in mathematics are designed to carry out is to teach pupils new concepts vocabulary, principles, skills and problem solving strategies. Even though pupils are able to learn the concepts described in these texts, most of the vocabulary which enables them to use the principles involved in the concepts are soon forgotten. This is because many teachers play down the role which the ability to read and recognise words can play in the child's mathematical understanding. Children need opportunities to use mathematical words in the second language in simple oral and written sentences if they should understand and remember later the mathematics they learn.

One way to do this is to include in the children's mathematics exercises tasks which require recognition, and use, of words and ideas which have recently been learned. Exercises such as those below can help children to use concepts and the associated vocabularies in simple mathematical sentences.

Exercise 1

Complete the sentences using the words and figures below

Akua went to market with _____. She paid _____ for some _____. She bought _____ fingers of banana. She bought the banana at _____ Akua spent _____ and had _____ left.

¢60; forty cedis; three for ¢10; ¢20; twelve;
hundred cedis; roasted groundnuts

Exercise 2

The steps needed to do a piece of mathematics have been written in any order. Can you re-write these sentences in the correct order:

- A. Put the sticks into groups of three**
- B. How will you work ' $12 \div 3$ '?**
- C. Count the number of groups you can make?**
- D. Count twelve sticks.**

The first exercise involves leaving blanks in a text but providing sufficient linguistic and mathematical cues for these blanks to be filled in. The second exercise involves sequencing a number of simple sentences which describe steps required to do a piece of mathematics.

There is some evidence to show that, particularly 'or less' able children, mathematics should be presented in language which is at a reading level one year below the actual reading age of the children (MacNab and Cummine, 1986). Mathematics materials which are selected in textbooks for children's exercises should be those which will suit their reading abilities and they should be encouraged to read them in an active reading process. Mathematical texts such as those in exercises Exercises 3, 4 and 5 are examples of simple texts which can be used in the upper classes of the primary school to improve children's reading ability and their precise use of English in giving explanations.

Exercise 3

**A market woman has 96 eggs.
Each box contains 6 eggs.
The eggs are in boxes.**

What can the woman do to find out how many boxes she will need for all her eggs?

Exercise 4

This is a short number story.

'Kofi has 3 baskets. There are 6 oranges in each basket. There are 18 oranges in all the baskets'.

1. Can you draw pictures to tell the story?
2. Can you write a number sentence that goes with the story?

Exercise 5

This is another short number story.

Ama sells oranges and pears. A pear costs ₦200 more than an orange. Kuma bought the same number of pears as oranges at a total cost of ₦6,000.

What is the cost of each pear if Kuma bought a total of 10 pears and oranges?

In using such texts, teachers should ensure that pupils really get involved in the text, not just reading it as they would read a story and follow it up with questions which will stimulate discussion. The belief that, in pupils' written work, the use of English should be kept to a minimum because it slows down the solution process will make it hard for many teachers to adopt processes of problem solving that set out solutions with explanation.

In any case, it is important for every teacher to present new concepts to children in a variety of situations before engaging them in working sums. We should not be too hasty in rushing on to *sums* given out of context because that can leave many children with few strategies to link a problem situation with the relevant mathematical representation.

Besides good reading skills, the child is also required to be familiar with the manner in which problems are presented in different contexts. This requires that teachers help children to identify the different forms in which a learned concept may be presented in a problem. For primary school work, the formats described below, which were suggested by Souviney (1984), can be used in helping children to identify the different demands that a word problem may pose:

No-number Problem:

This might be a story problem which does not require numbers in the solution; presented orally, graphically or using symbols. An example is Exercise (1) above.

Headline Problem:

Headline in this context refers to a mathematical sentence or a number sentence. This is a problem which requires children to find the mathematical sentence that matches with the problem statement, or making one's own problem. This does not usually require any calculation. Examples are Exercises. (4).

Number Problem:

This is a problem which requires children to identify the appropriate operation(s), write an open number sentence and compute its solution. An example is Exercise. (5).

It is only when pupils have been able to read and discuss problems in the first two formats that they will be able to find the right mathematical representations when faced with similar problems which require the use of mathematical operations.

Teaching Mathematics Across the Curriculum

Most primary pupils who are taught in a second language are not provided with adequate opportunities to develop mathematical ideas through informal oral language before the written language and mathematical symbols are introduced. Clements (1984) suggested that 'for such pupils it is vitally necessary that language teaching is designed in

collaboration with mathematics teaching, so that language is available to express mathematical concepts as they are developed.'

Mathematics can be integrated with language teaching by introducing mathematics texts into English (or Ghanaian language) conversation lessons in addition to lessons on such general topics as 'the post office', 'the market', 'the hospital', etc. Conversation lessons can also be conducted with topics which can stimulate mathematical thinking. The activities described under the topics in Exercises e, f, and g below (adapted from Angela Walsh, 1988) are examples of mathematical texts which can be used in English conversation lessons

Exercise 6

What's the difference?

Choose two objects.

Ask the children to tell you all the differences they can find between the two objects. It could be differences in colour, shape, length, weight or texture, but they are sure to find all sorts of differences which adults would never think of!

Exercise 7

I Spy

A bird has two legs, a cat has four legs, an insect has six legs, a spider has eight legs.

I spy with my little eye - ten legs. Do I see a dog and a fly or four birds or what?

Make up some of your own number stories and try them out on a friend.

Try and find some pictures of animals and insects or birds and use these to spy with your little eye.

Exercise 8

How much

Suppose you are to be given twenty pesewas. What coins could be used to make the 20p?'---

One possibility is $10p + 5p + 2p + 2p + 1p$.

Suppose you are given another 20p each time you discovered one more possibility.

How much could you receive all together?

Begin by using real coins to provide a practical focus to this activity. But as strategies develop, try using paper and pencil or a calculator.

Problem solving should not be confined to only mathematics lessons. It should appear in all activities which children undertake in exploring their environment; it could be science, environmental studies, topic work, project work, home economics or physical education.

In order to minimise the difficulties with unfamiliar materials used in books, teachers should ensure that texts selected from mathematics textbooks match with materials taught in other subjects. For instance, problems involving cents and dollars used in Liberia, which appear in the 'Ghana Mathematics Series Book 3', should be delayed until discussions on 'monies or currencies used in neighbouring countries' have been covered in social or environmental studies.

Summary and Recommendations

Mathematical skills which people need to use and the specific calculations which people need to do in the real world do not arrive neatly phrased in a textbook style or labelled with the appropriate procedures to use. The evidence is that many children have difficulties in solving problems. A child who may have a mathematical skill cannot solve a

problem because he/she does not understand the mathematics when it is mixed with language and context.

We do not seem to recognise the role that language can play in the learning of mathematics and tend to ignore the difficulties that children often encounter with language in the learning of mathematics. By encouraging the use of language and discussion during mathematical activities, children will have a better understanding of what they learn. If we

agree that the long term goal for the child's mathematics education is to enable him to solve problems that he will be meeting in life, then we have to assist him to learn the skills required in the medium in which he will be meeting these problems.

Learning to solve problems in one's language means learning to reason in that language. I would therefore like to suggest that a lesson is created separately on the primary school time-table for teaching mathematical problem solving. Problem solving lessons in the early primary years should be conducted mostly in the first language. We have to ensure that children can solve a variety of problems in their own language before they are asked to solve these problems in English.

References

- Angela Walsh, 1988 *Help your child with Maths* London: BBC Books,
- Clements, Ken (1984) 'Origins of Conceptual Difficulties', In: Robert Morris (Ed),
- Clements, M.A. (1980) 'Analyzing children's errors on written Mathematical Tasks' *Educational Studies in Mathematics, Vol. 11 No.1* D. Reidel, Publishing Company, Holland
- Collison, G.O. (1975) 'A Comparison of the use of an African Language with English as the Medium of Education in Science at Primary Level', in: *Languages and the Teaching of Science and Mathematics* London: CASTME,
- Dawe, L. (1983) 'Bilingualism and Mathematical Reasoning In English as a Second Language' *Educational Studies in Mathematics, Vol. 14* D. Reidel Publishing Company, Holland
- Macnab, D.S. and Cunimine, J.A. (1986) *Teaching Mathematics 11-16: A Difficulty-Centred Approach* Great Britain: Basil Blackwell.

- Ministry of Education (1988) *Ghana Mathematics Series Books 1 - 6*, Accra: CRDD – GES.
- Newman, M.A, (1977) 'An Analysis of Sixth Grade Pupils' Errors in Written Mathematical Tasks', In: Clements, Maud Foyster, J. (Ed) *Research on Mathematics in Australia (1)*
- Nicholson, A.R. (1977) 'Mathematics and Language', *Mathematics in School. Vol. 6 No.5*. Liecester: The Mathematics Association, London
- Orton, A. (1987) *Learning Mathematics: Issues, Theory and Classroom Practice* London: Cassel Education.
- Otterburn, M.K. and Nicholson, A.R. (1976) Language of (CSE) Mathematics, *Mathematics in School, Vol. 5. No.5*. London: The Mathematics Association.
- Souviney, R.J. (1984) 'Working Story Problems', In: Robert Morris (Ed) *Studies in Mathematics Education*, Paris *Vol.3*. UNESCO
- Torbe Mike, (1982) *Language Teaching and Learning (6) MATHEMATICS*, London: Wark Lock Educational.
- Vygotsky, L.S. (1962) *Thought and Language* M.I.T. Press/Wiley,